



Research Article

STUDY ON PREVALENCE OF FLUOROSIS AMONG SCHOOL CHILDREN AND COMMUNITY AND ASSESSMENT OF STATUS OF FLUORIDE AND MICROBIOLOGICAL CONTAMINATION OF DRINKING WATER IN A RURAL COMMUNITY OF WEST BENGAL

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ABSTRACT

Background: Excessive fluoride in drinking water causes dental, skeletal and non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world including India. As per WHO guide line and the Bureau of Indian Standard (BIS), the permissible upper limit of fluoride in drinking water is 1.5 mg/L. Presence of Dental fluorosis among school children generally accepted as one of the best and reliable indicator of fluoride exposure. **Objective:** To determine the prevalence of signs and symptoms of suspected dental, skeletal, and non-skeletal fluorosis, along with food habits, addictions, and use of fluoride containing toothpaste among school students and community people taking water with fluoride concentration above the permissible limit in the selected affected village of Birbhum District of West Bengal. To create awareness and impart hands on training of the field workers and school teachers and community for early identification of cases of fluorosis and timely referral and to estimate Fluoride level and the biological quality of water used by the participants for drinking and cooking purpose. **Methodology:** A cross sectional study was conducted in 2 schools of Jamrand village of Kendgore GP of Khoyrasol block of Birbhum district of West Bengal to assess the occurrence of various dental, skeletal, and non-skeletal manifestations of fluorosis, along with food habits, addictions, and use of fluoride containing toothpaste among the study population (school children and community). Fluoride level and the biological quality of water used by the participants for drinking and cooking was also assessed. **Results:** Out of 250 children screened 42.8% children were found to be having Dental Fluorosis and majority of them were female (56%) and majority of students belonging to 6-9 yrs of age (75%). 72% of these students had mild disease, 24% moderate and only 4% had severe disease. Prevalence of Dental Fluorosis was 27% in the Community and majority of them were males aged 40-60 yrs. 9-18% of the populations were suffering from various symptoms of skeletal fluorosis and 8-31% of population were having various symptoms of non-skeletal fluorosis. 53.33% of water samples collected from these household tube wells contained E Coli which is an indicator of microbiological contamination of water. Out of these Total Coliform count of water from 20% household tube wells were found to be equal or more than equal to 10 per 100ml indicating likely fecal contamination of water. **Conclusion:** Increased prevalence of dental, skeletal, and non-skeletal fluorosis was found among the study population along with high level of Fluoride and coliforms in tube well water. Withdrawal of source(s) identified for fluoride by supplying domestic and community filters, dietary restriction, nutritional interventions, motivation to use piped water supply and regular monitoring, supervision and testing of piped water supply are urgently needed to address these serious but somewhat neglected public health problems.

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INTRODUCTION

Fluoride is one of the important factors in water quality management due to its adverse health effects. The problem of high fluoride concentration in groundwater resources has become one of the most important toxicological and geo-environmental issues in India. Excessive fluoride in drinking water causes dental, skeletal and, non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world.¹ Twenty out of 35 States and Union Territories of India were identified as endemic for fluorosis² and about 66 million people in these regions are at risk of fluoride contamination including 6 million children below 14 years of age and affecting about 25 million people.³

Fluoride ingestion through water is the major cause of fluorosis. WHO guideline value and the permissible upper limit of fluoride as per Bureau of Indian Standard (BIS) is 1.5 mg/L.³ Fluorides are released into the environment naturally through the weathering of minerals, emissions from volcanoes and marine aerosols. The main natural source of inorganic fluorides in soil is the parent rock. Fluorosis is a crippling disorder known to occur due to the entry of fluoride into the body. It is a slow, progressive, crippling malady that affects every organ, tissue and cells in the body and results in health complaints that overlap with several other disorders. The disease manifestations occur over a period of time. The time or duration required for clinical manifestations to appear varies depending on several factors, viz., age, hormonal status, nutritional status, efficiency of the kidney to excrete fluoride,

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the quantum of fluoride entry into the body, climatic conditions etc.³ Most of the fluorides are readily soluble in water. Dental fluorosis affects the permanent teeth of children with clearly visible discoloration on the teeth after 8 years of age. Dental fluorosis is a good indicator of exposure to excessive amounts of fluoride.

In the states of Assam, Jammu & Kashmir, Kerala, Chhattisgarh and West Bengal 10-40% of districts are affected.³ In West Bengal fluoride was first detected at Bhubanandapur in Nalhati I block of Birbhum district in 1996. During rapid assessment survey (2005), 729 sources were found contaminated with fluoride above 1.5 mg/L in 43 Blocks of seven Districts of West Bengal with affected population of approx. 2.26 lakhs with fluoride level varying from 1.1-4.47 mg/L.^{4,5}

Studies show that withdrawal of sources identified for fluoride often leads to reduction of fluoride in the body fluids (re-testing urine and serum after a week or 10 days) and results in the disappearance of non-skeletal fluorosis within a short duration of 10-15 days.^{5,6}

Fluorosis is an impending public health problem in West Bengal affecting a large number of population, and Birbhum is one of the affected districts with seven affected blocks.

Drinking water is also a major source of microbial pathogens in developing regions including India, although poor sanitation and food sources are integral to enteric pathogen exposure. Gastrointestinal disease outcomes are also more severe, due to under-nutrition and lack of intervention strategies in these regions. Poor water quality, sanitation and hygiene account for some 1.7 million deaths a year worldwide (3.1% of all deaths and 3.7% of all DALY's), mainly through infectious diarrhoea. Nine out of 10 such deaths are in children and virtually all of the deaths are in developing countries. Disease-causing organisms (pathogens) transmitted via drinking water are predominantly of faecal origin.⁷ The total coliform test is the basic yardstick for determining the biological quality in a water supply. The total coliform group is a large collection of different kinds of bacteria. Fecal coliforms are types of total coliform that mostly exist in feces. *E. coli* is a sub-group of fecal coliform.

To address the health impact of having fluoride contaminated water for drinking and cooking and to assess the biological quality of water, a study was conducted in the Khoyrasol block of Birbhum District of West Bengal.

Objective of the study

- To determine the prevalence of signs and symptoms of suspected Dental, Skeletal and non-skeletal fluorosis along with the food habits, addictions and use of fluoride containing toothpaste among school students and community people taking water with fluoride concentration above permissible limit in the selected affected village of Khoyrasol block of Birbhum District of West Bengal.
- To create awareness and impart hands on training of the field workers and school teachers and community for early identification of cases of fluorosis and timely referral.
- To estimate Fluoride level and to assess the biological quality of water used by the participants for drinking and cooking purpose.

METHODOLOGY

Khoyrasol block of Birbhum district in West Bengal is endemic for fluorosis which is selected for the study based on the water quality reports of PHED (Public Health Engineering Department), Govt of West Bengal. In Khoyrasol block, Kendgore and Panchra GPs were selected for the study due to presence of high concentration of fluoride in hand pumps (> 20mg/lit) where permissible limit is 1 mg/ lit (BIS) and WHO guideline value is 1.5 mg/ lit.

A cross sectional study was conducted in 2 schools of Jamrand village of Kendgore GP and adjacent community of Khoyrasol block of Birbhum district of West Bengal to assess the occurrence of various dental, skeletal, and non-skeletal manifestations of fluorosis, along with food habits, addictions, and use of fluoride containing toothpaste among the study population (school children and community) in February, March 2023. These 2 schools in Jamrand village of Kendgore GP of Khoyrasol block were selected for the study based on the high level of Fluoride in their drinking water source.

Ethical clearance was obtained prior to the initiation of study and after taking consent from the Head Master, 250 Children belonging to class I and class IV (6-12 yrs of age) of the above selected schools were screened for dental fluorosis along with testing of their drinking and cooking water source for fluoride and microbiological concentration.

House to house survey was also conducted to identify fluorosis patients in the community and to create awareness among them. 20 families with app 110 family members were selected randomly out of families having past history of taking water from an unsafe source in the above villages.

After taking informed consent the selected family members were interviewed by trained personnel with a pretested questionnaire to obtain general information including their sources of drinking water, diet, personal details (including smoking, drinking, and addiction), medical history and occupational history. Enrolled study subjects were clinically examined by doctor (Fluoride expert) for evidence of fluorosis (dental/skeletal/non skeletal). Based on the clinical examination, they were categorized as fluorosis affected patients as per case definitions and diagnostic criteria developed by Fluorosis Research & Rural Development Foundation, New Delhi.^{3,6}

The family members were also motivated to use only safe water for their drinking and cooking purposes and to follow the nutritional advice and they would be monitor continuously by the fieldworkers in future. Surveillance of health status of the family members by the field workers was also ensured for which two field level data collectors and one sample collector was selected based on their experience in conducting any health survey. They were trained by the fluorosis expert for collection of health and other socio demographic data along with collection of water samples.

Water was collected from tube wells and arrangement was made for testing in a local water testing laboratory of PHED at Khoyrasol.

RESULTS

Results of study among school children.

Out of 250 children screened 107 (42.8%) children were found to be having Dental Fluorosis.

Majority of the students having dental fluorosis belong to 6-9 yrs of age (75%) and were female (56%). 72% of these affected children had mild disease i.e. early stage, 24% moderate and only 4% had severe disease. Majority of school children having moderate to severe dental fluorosis were from Kendgore village where piped water supply was recently installed but coverage was not adequate. (Table I & II & Fig I & II). Majority of school children (65%) having Dental fluorosis were still taking water from home tube wells for cooking and drinking purpose. Remaining 30% were getting water from piped water supply and remaining 5% getting water from dug well. Piped water connection was there in the school but not adequate considering the number of students. Situation is worst in summer when students often had to fetch water from outside school premises during Tiffin hours.

Table I Distribution of school children with Dental Fluorosis according to gender

Male		Female		Total	
No	%	No	%	No	%
47	44	60	56	107	42.8

(N= 107)

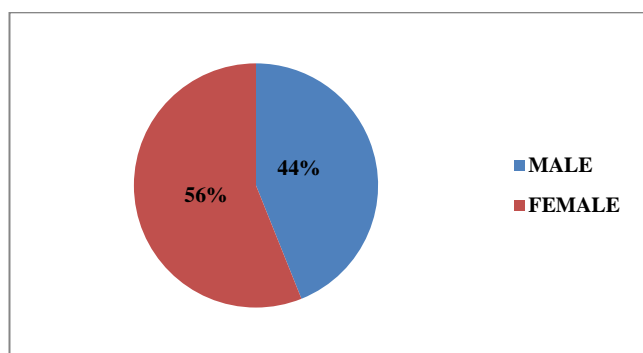


Figure I Distribution of school children with Dental Fluorosis according to gender
Majority of the students were female 56%

Table II Distribution of school children with Dental fluorosis according to age (N=107)

Age in years	No.	%
6-7	39	36.4
8-9	41	38.3
10-11	23	21.5
≥ 12	4	3.8
Total	107	100

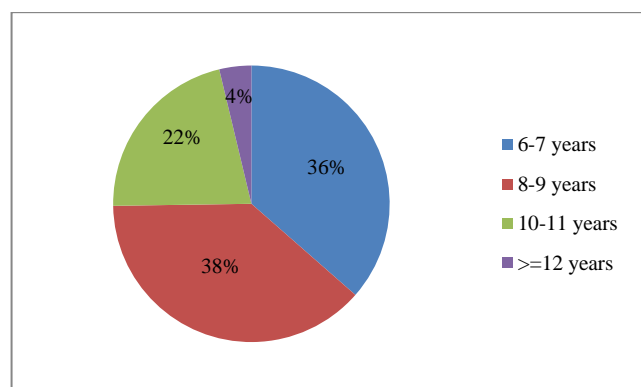


Figure II Distribution of school children with Dental fluorosis according to age (N=107)

Table III Distribution of population in the community according to disease manifestations at Khoerasol Block. (N = 110)

Disease Manifestations	Khoerasol Block	
	No.	%
Dental Fluorosis	30	27
Lactating / Pregnant mothers	Nil	Nil
Abortion/Still Births	Nil	Nil
Skeletal Fluorosis		
a) Touch the chin with the chest (inability)	15	13.6
b) Bend to touch the toes (inability)	20	18.1
c) Stretches arm to touch the back of the head (inability)	10	9.1
NonSkeletal Fluorosis		
a) Pain in the stomach	20	18.1
b) Bloating or flatulence	30	27.3
c) Loss of appetite	35	31.8
d) Constipation followed by diarrhoea	10	9.1
e) Polyurea/ Polydypsia	9	8.2
f) Fatigue/Depression	35	31.8
g) Muscle weakness	9	8.2
Fluoride Toothpaste Consumption of food	48	43.6
a) Supari	10	9.1
b) Tobacco	20	18.1
c) Black lemon tea	52	47.2
d) Black rock salt	Nil	Nil
e) Adequate intake of Fruits & Vegetables	56	50.9
f) Adequate intake of Fish & egg	42	38.1

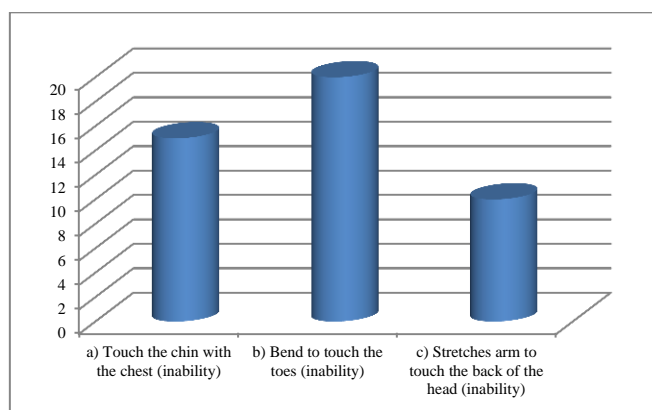


Figure III Distribution of population according to disease manifestations (Skeletal Fluorosis) at Khoerasol Block (N = 110)

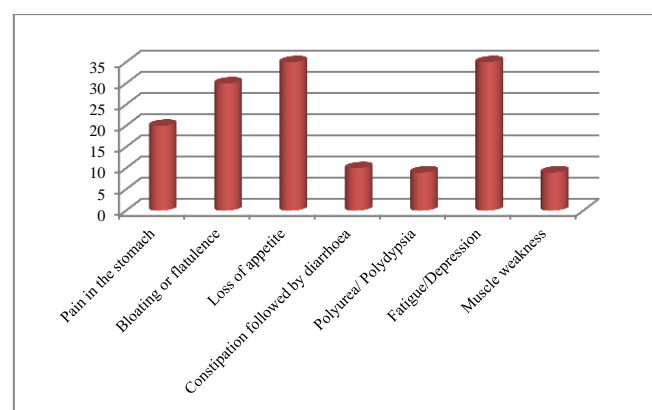


Figure IV Distribution of population according to disease manifestations (Non Skeletal Fluorosis) at Khoerasol Block (N = 110)

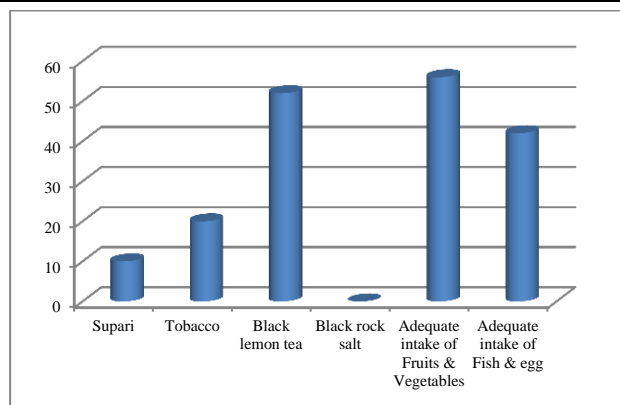


Figure V Distribution of population according to lifestyle at Khoerasol Block (N = 110)

Results of Study among Community

Prevalence of Dental Fluorosis is 27% in the Community. Majority of patients were males aged 40-60 yrs. 9-18% of the populations were suffering from various symptoms of skeletal fluorosis. (Fig III) and 8-31% of population were having various symptoms of non-skeletal fluorosis. (Fig IV). 43.6% of population was found to be using fluoride containing tooth paste and 47% were taking black tea. (Fig V). 51% of population was taking fruits and vegetables and 38% were taking fish or egg regularly. In the present study tobacco consumption in any form was found in 18% of subjects (Table III & Fig III, IV, V).

Water testing report

Around 30 samples of water were collected from household domestic tube wells of Panchra and Kendgore panchayets of Khoerasol Block of Birbhum District of West Bengal and tested in District Water Testing Laboratory under office of the Executive engineer, PHED, Birbhum Division, Govt of West Bengal for various physical and chemical parameters as well as microbiological contaminants. Coliform count was also estimated.

The students of two schools (one primary and one secondary) of Jamrand village having dental fluorosis were found to be using the water from these tube wells for drinking and cooking.

Out of total 30 water samples collected from domestic tube wells it was found that Fluoride level of two Domestic (Household) tube wells one in Panchra Nichpara in Namupara habitation of Panchra village and another in Purbo Borkola habitation in Purbo Borkola village was 20.4mg/lit and 9.41mg/l respectively which were much higher than the desirable limit of 1 mg/ lit (BIS) and permissible limit of 1.5 mg/ lit. Value of fluoride levels of other tube wells were found to be within normal range.

Surprisingly 16 out of 30 i.e. above 50% (53.33%) of water samples collected from these household tube wells contain E Coli which is an indicator of microbiological contamination of water. Out of these Total Coliform count of water from 6 (20%) household tube wells were found to be equal or more than equal to 10 per 100ml indicating likely fecal contamination of water. 10 water samples (33.3%) had total coliform count 1-9. Ideally water samples intended for drinking and cooking should not contain E Coli. Vicinity of these tube wells with latrine or polluted water bodies or other sources of contamination (<50 feet or <15 meters) and lack of

proper maintenance of these tube wells may be responsible for these contamination. One of these tube well having high coliform count (>10 CFU/100ml) was found to be located near an ICDS center (Bagdipara ICDS Center) in Purbo Borkola and another near Kendragaria high school (Total Coliform count 5 CFU/ 100 ml) and beneficiaries of ICDS and school students were found to be using the water from these tube wells for drinking and cooking purpose.

DISCUSSION

In the current study it was found that out of 250 children screened 42.8% children were found to be having Dental Fluorosis and majority of the students having dental fluorosis belong to 6-9 yrs of age (75%) and were female (56%). 72% of these students had mild disease i.e. early stage, 24% moderate and only 4% had severe disease. However prevalence of Dental Fluorosis was 27% in the community and majority of them were males aged 40-60 yrs. 9-18% of the populations from the community were suffering from various symptoms of skeletal fluorosis and 8-31% of population were having various symptoms of non-skeletal fluorosis. Choubisa in his study in southern Rajasthan found that overall prevalence of dental fluorosis was 45.7%⁸. Pushpa Bharati *et al* in their study in Gudag & Bagalkot districts of Karnataka found prevalence of dental fluorosis to be 35%⁹. Similar positive correlation between fluoride concentration and DFI (Dental Fluorosis Index) score was also found in other studies.¹⁰⁻¹⁴

In the present study, the baseline prevalence of manifestations of skeletal fluorosis was found to be 9-18% and 8-31% of population were having various symptoms of non-skeletal fluorosis. Pushpa Bharati *et al* in their study in Gudag & Bagalkot districts of Karnataka found prevalence of skeletal fluorosis 17% and both types 12.67%⁹. Choubisa in his study in southern Rajasthan found that overall prevalence of skeletal fluorosis was 22%⁸. Joint pain was found in 31.87% subjects in study done by Pushpabharati *et al*⁹. Narayana *et al* reported joint pain, neck stiffness in 50-70% of cases¹⁵. Shashi *et al* in their study in 3 endemic areas of Punjab state observed back pain (73%) and neck pain (34%) as skeletal fluorosis symptoms¹⁶.

According to Susheela *et al* if nutritional intervention focusing on adequate intake of fresh green vegetables and fruits containing calcium, iron, vitamin C and E and other antioxidants is practiced simultaneously along with safe drinking water, features of adverse health effects get reduced faster⁶. In this study it was found that 51% of population taking fruits and vegetables containing antioxidants and 38% were taking fish or egg regularly.

In the present study tobacco consumption in any form was found in 18% of subjects. Kubakaddi *et al* observed that 40% of the tobacco chewers were suffering from dental & skeletal fluorosis.¹⁷

Five hundred and twenty-five 5- to 12-year-old school children studying in six primary schools of six villages in Chidambaram were surveyed. The overall dental fluorosis prevalence was found to be 31.4%. Dental fluorosis increased with age ($P < 0.001$), whereas gender difference was not statistically significant.¹⁸ Majumdar 2019 in his study in 2 primary schools in Purulia District of West Bengal found that out of 136 children 33.82% children had Dental fluorosis

(80% mild and 20% - Mod) in both the schools. Overall Dental Fluorosis was found to be more common in the age group of 12-14 yrs (36.9%) and males (52.2%) are more commonly affected than females.¹⁹

Although the description of disease was done long back in early 1930 by eminent Indian physicians,²⁰ not much has been done till date regarding its mitigation measures. However in order to address the problem of fluorosis in the country, National Programme for Prevention and Control of Fluorosis was launched in 2008-09 with an objective to collect, assess and use the baseline survey data for fluoride mapping along with comprehensive management and capacity building.^{21,22} Increased provision of alternate safe water source by the use of domestic filters at the household level and at the community level treatment of surface water, rain water harvesting, ground water recharge along with community participation, awareness generation and nutritional intervention can solve the problem of fluorosis to a great extent on a long term basis. Permanent solution by treated safe water supply through pipes may be the ultimate solution although piped water supply has already started in that area under Jal Jeevan Mission by PHED but whole village is yet to receive adequate quantity of safe water.

WHO (World Health Organisation) estimates that about 1.1 billion people globally drink unsafe water. Poor water quality, sanitation and hygiene account for some 1.7 million deaths a year world-wide mainly through infectious diarrhoea. Nine out of 10 such deaths are in children and virtually all of the deaths are in developing countries. Disease-causing organisms transmitted via drinking water are predominantly of faecal origin.⁷ In the current study more than 50% (53.33%) of water samples collected from these household tube wells contained E Coli which is an indicator of microbiological contamination of water. Out of these Total Coliform count of water from 20% household tube wells were found to be equal or more than equal to 10 per 100ml indicating likely faecal contamination of water. 33.3% of water samples had total coliform count 1-9. Ideally water samples intended for drinking and cooking should not contain E Coli. Vicinity of these tube wells with latrine or polluted water bodies or other sources of contamination (<50 feet or <15 meters) and lack of proper maintenance of these tube wells may be responsible for these contamination. One of these tube well having high coliform count (>10 CFU/100ml) was found to be located near an ICDS center and another near a high school (Total Coliform count 5 CFU/ 100 ml) and beneficiaries of ICDS and school students were found to be using the water from these tube wells for drinking and cooking purpose. The contaminant sources might be due to natural soil, animal waste, human waste, dead animals, incidental dirty water, or trash and rubbish. During the installation or maintenance work of pipelines, there may be some potential contamination sources such as unsanitary human contact, sewage water, or agricultural runoff in the trench. In a study in the Tarkwa mining area in the Western Region of Ghana it was found that 82.58% of surface water and 71% of groundwater sources had total coliform while 54.55% of surface water and 54% of ground water locations had faecal coliform. Total coliform and faecal coliform have been chosen for the study mainly because of their faecal and environmental origin and could also be monitored.²³ In a study in Sikkim microbial confirmatory

testing indicated severe faecal contamination of water sources with high counts of total coliform (TC), Escherichia coli (EC) and Enterococcus (EN). The highest level of TC was recorded from West Sikkim (37.26 cfu/100 ml) and the lowest in North Sikkim (22.13 cfu/100 ml). The highest level of contamination of E. coli and Enterococcus was found in East Sikkim (EC = 8.7 cfu/100 ml; EN = 2.08 cfu/100 ml) followed by South Sikkim (EC = 8.4 cfu/100 ml; EN = 2.05 cfu/100 ml).²⁴

CONCLUSION

In the current study increased prevalence of dental, skeletal, and non-skeletal fluorosis was found among the study population along with high level of Fluoride and coliforms in household tube well water. Withdrawal of source(s) identified for fluoride by supplying domestic and community filters, dietary restriction, nutritional interventions, motivation to use piped water supply and regular monitoring, supervision and testing of piped water supply are urgently needed to address these serious but somewhat neglected public health problems.

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